Antimicrobial Resistance Patterns of *Salmonella* Isolates Collected from Slaughter Age Pigs

Fedorka-Cray PJ[1], Bahnson, PB[2], and Ladely, SR[1]

[1] USDA:ARS Richard Russell Research Center, Athens, GA, USA

[2]Department of Veterinary and Clinical Medicine, University of Illinois, Urbana-Champaign, IL, USA

Introduction

Salmonellae are ubiquitous in nature and are recovered from many animal species including swine. However, prevalence of specific serotypes can vary (1). Although carriage is often observed, fecal shedding can be sporadic (2). *Salmonella*, as well as other food borne pathogens, can be transferred from animals to the human population. However, since the federally mandated HACCP program has been implemented, a reduction in *Salmonella* among the major food animals has been observed (3).

Most swine that carry Salmonella do not exhibit clinical signs of illness and treatment is not indicated. However, antimicrobics are used in swine production for the treatment and prevention of illness as well as for growth promotion. Use of antimicrobics in some cases can lead to the development of resistance to the antimicrobics and resistance can either diminish effectiveness or render an antimicrobic ineffective as a therapeutic. Although use may result in a population of bacteria that are resistant, the exact fate of this population in terms of persistence and transmission has been difficult to determine. In this report, we describe the antimicrobial resistance patterns of *Salmonella* isolates collected from pigs on farm and subsequently at slaughter.

Materials and Methods

The study design has been previously described (4). Briefly, fifteen pigs were individually identified on each of 70 farms. Rectal samples were collected both at the farm (FF) and at the slaughter plant (PF). Cecal contents (CC) and caudal mesenteric lymph nodes (LN) were also collected at slaughter. All samples were individually cultured, maintaining pig and farm identity.

Bacteriology was conducted as previously described for all samples with the exception of LN (5, 6). Approximately 10 g of LN was placed into 100 ml of tetrathionate broth, incubated for 48h then subcultured as described. All isolates were stored at -70°C

Antimicrobial susceptibility testing of the *Salmonella* isolates was conducted using a semi-automated system (Sensititre™, Trek Diagnostic, Westlake, OH) according to manufacturer's instructions. Plates were custom made with 16 antimicrobics using a breakpoint configuration. Antimicrobics tested included: Amikacin, Amoxicillin/ Clavulanic Acid, Ampicillin, Apramycin, Cefotaxime, Ceftiofur, Cephalothin, Ciprofloxacin, Gentamicin, Neomycin, Piperacillin, Sulfamethoxazole, Tetracycline, Ticarcillin, Ticarcillin/Clavulanic Acid and Trimethoprim/ Sulfamethoxazole.

Results

A total of 4,124 samples were processed from 1,057 pigs on 70 farms. Of these, 422 samples were positive from 294 pigs and 55 farms. Salmonella was most often recovered from the CC (17.4% positive), followed by the LNs (13.9%), FF (5.4%) and PF (4.0%) (4). For this portion of the study, 351 samples from the first 50 farms were tested for antimicrobial resistance. All isolates were susceptible to Amikacin, Cefotaxime, Ceftiofur and Ciprofloxacin. Percent resistance for the remaining antimicrobics is shown in Table 1. Percent resistance by sample type (FF, PF,LN and CC) is also shown in Table 1. With the exception of Apramycin, Gentamicin, Sulfa and Tetracycline, more resistance is observed from the LN than any other sample type. The five most common serotypes recovered from all isolates were *S. derby* (23.93% positive), *S. typhimurium* (including var. *copenhagen*; 15.67%), *S. agona* (11.68%), *S. schwarzengrund* (11.4%) and *S. senftenberg* (8.83%). Percent resistance by serotype is shown in Table 2.

Table 1. Total percent resistance and total percent resistance by sample type for *Salmonella* isolates

			% Resistance		
Antimicrobic	**Total n=351**	**FF n=46**	**PF n=36**	**LN n=110**	**CC n=152**
Amikacin	0	0	0	0	0
Amox/Clav Acid	0.28	0	0	0	0.66
Ampicillin	10.54	8.7	5.56	16.36	8.55
Apramycin	1.71	0	0	0.91	3.29
Cefotaxime	0	0	0	0	0
Ceftiofur	0	0	0	0	0
Cephalothin	0.28	2.7	0	0	0
Ciprofloxacin	0	0	0	0	0
Gentamicin	1.42	0	0	0.91	2.63
Neomycin	11.11	4.35	8.33	19.09	8.55
Piperacillin	7.69	2.17	5.56	13.64	5.92
Sulfamethox	29.06	23.91	22.22	26.36	35.53
Tetracycline	47.58	56.52	38.89	36.36	56.58
Ticarcillin	10.54	8.7	5.56	16.36	8.55
Ticar/Clav Acid	2.28	0	0	4.55	1.97
Trimeth/ Sulfa	0	0	0	0	0

Discussion

The highest percent resistance is observed predominately for the older, more commonly used antimicrobics such as Sulfamethoxazole, Tetracycline, and Ampicillin. Although Ampicillin is not used in swine production, cross-resistance between Penicillin, which is commonly used, may account for the observed resistance. Interestingly, with the exception of the antimicrobics noted above, more resistance is observed for the LN than any other sample type. The LN and CC are considered to be main tissues of predilection for colonization (2). While the CC may represent a less stable environment for long term colonization, translocation into the LN readily occurs (7) and may provide a site for persistence. Populations of bacteria that reside for longer periods within the host may then be more prone to acquiring resistance attributes than those in transient passage.

Difference in resistance among serotypes was also observed. The more common serotypes, *S. derby* and *S. typhimurium* and to a lesser extent *S. agona* appear to be more resistant than the other serotypes. *Salmonella typhimurium* is often more resistant than other serotype (8) and is known to acquire multiple resistance (9). An analysis of sample type by serotype may account for the distribution of resistance that is observed in this study. Other analyses within a farm tracking both serotype and resistance will be conducted.

TABLE 2. Total percent resistance by serotype

			% Resistance		
Antimicrobic	**S. derby n=84**	**S. typhimurium n=50**	**S. agona n=41**	**S. schwarzengrund n=40**	**S. senftenberg n=31**
Amikacin	0	0	0	0	0
Amox/Clav Acid	0	1.82	0	0	0
Ampicillin	0	60	0	0	0
Apramycin	3.57	0	0	2.5	0
Cefotaxime	0	0	0	0	0
Ceftiofur	0	0	0	0	0
Cephalothin	0	0	0	0	0
Ciprofloxacin	0	0	0	0	0
Gentamicin	2.38	0	2.38	2.5	0
Neomycin	0	49.09	7.14	0	0
Piperacillin	0	45.45	0	0	0
Sulfamethox	73.81	52.73	7.14	0	0
Tetracycline	86.9	49.09	38.1	2.5	47.19
Ticarcillin	0	60	0	0	0
Ticar/Clav Acid	0	14.55	0	0	0
Trimeth/ Sulfa	0	0	0	0	0

References

1. Davies, P.R., W.E.M. Morrow, F.T. Jones, J. Deen, P.J. Fedorka-Cray, and I.T. Harris. 1997. Prevalence of salmonella in finishing swine raised in different production systems in North Carolina, USA. Epidemiol. Infect. 119:237-244.

2. Gray, J.T., P.J. Fedorka-Cray, T.J. Stabel, and T.T. Kramer. 1996. Natural transmission of *Salmonella choleraesuis* in swine. Appl. Environ. Microbiol. 62:141-146.

3. USDA-FSIS HACCP Implementation: First Year. 1999. Http:// www.fsis.usda.gov/OPHS/saldata.htm

4. Bahnson, P.B. and P.J. Fedorka-Cray. 1997. The associations between herd characteristics and salmonella in slaughter age pigs. pp.145-146. *In* Proceedings of the 2nd International Symposium On Epidemiology and Control of Salmonella in Pork, Copenhagen, Denmark.

5. Fedorka-Cray, P.J. J.T. Gray and L.A. Thomas. 1995. Comparison of culture media for the isolation of *Salmonella*. pp.116-123. In Proceedings of the Symposium on the Diagnosis of Salmonella Infections, Reno, NV.

6. Fedorka-Cray, P.J., D.A. Dargatz, L.A. Thomas, and J.T. Gray. 1998. Survey of *Salmonella* serotypes in feedlot cattle. J. Food Prot. 61:525-530.

7. Berends, B.R., H.A.P. Urlings, J.M.A. Snijders, and F. van Knapen. 1996. Identification and quantification of risk factors in animal management and transport regarding *Salmonella* spp. in pigs. Intl. J. Food. Microbiol. 30:37-53.

8. National Antimicrobial Resistance Monitoring System - Enteric Bacteria. 1997. Annual Report.

9. Threlfall, E.J., J.A. Frost, L.R. Ward, and B. Rowe. 1994. Epidemic in cattle and humans of *Salmonella typhimurium* DT104 with chromosomally integrated multiple drug resistance. Vet. Rec. 134:577.